A Review of research benefits

THE INDUSTRIAL RESEARCH ASSISTANCE PROGRAM

A REVIEW OF RESEARCH BENEFITS

THE INDUSTRIAL PROGRAMS OFFICE

National Research Council Canada
Conseil national de recherches Canada

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Introduction

The Industrial Research Assistance Program was originally conceived to assist industry to become more competitive and innovative by promoting the formation of research and development teams in industry. This purpose was achieved by the support of new research teams undertaking specific projects in Canadian companies.

Emphasis has since been given to directing the original aim to situations where the increased capability is likely to be the most useful and viable. Industrial research capability is not an end in itself but must be combined with other business skills and positions of strength which a company possesses, or can develop, in order to take the results to a successful commercial conclusion.

Under the terms of an IRAP grant, the Council provides financial assistance to an applied research project conceived by a company with an end product or process in view. To be eligible, companies must be incorporated in Canada, must undertake to do the major part of the proposed research in Canada, must exploit the results through Canadian operations and, finally, must have proper access to realistic export markets for the product.

Since 1962, when IRAP was put into operation, 230 companies have received financial assistance needed to undertake more than 450 research projects. This has involved an expenditure of $100,000,000, with industry contributing about 58 percent of this amount. Some 1,250 professional (35 percent at the Ph.D. level) and 950 technical positions have been created in industry as a result of the program. Projects have been undertaken in a wide spectrum of industries and in all areas of Canada. In this report, some of the more tangible benefits of these projects are reviewed.

Research Benefits of IRAP

It has become an accepted practice for the modern industrial state to provide assistance for the research and development activities of industrial firms in the private sector. This assistance is justified, in a general way, by the necessity of maintaining a technologically mature national industry that can contribute to the national economy and compete effectively in international business situations. More particularly, however, we should recognize that the benefits of industrial innovation go significantly beyond the confines of the particular firm to other centres of economic activity and to the eventual consumer. It is thus proper that

the state participate in the funding of industrial R&D in anticipation of benefits that will accrue to the nation.

The Industrial Research Assistance Program (IRAP) is not designed to offer broad based support applicable to any industrial scientific activity, but rather is directed to selected research projects of special potential to the national good. Consequently, it is important that an evaluation of the benefits of the program be an integral part of the program's administration.

IRAP support has been extended to companies in a wide range of areas of industrial activity, degree of technological sophistication and size of operations. It is evident that the results obtained must be judged in relation to the objectives and resources of the participating company. Large corporations offer the larger technical, marketing and financial resources often necessary to introduce novel advances in mature technology. International companies, experienced in competitive world markets, provide opportunities to exploit foreign markets and offer avenues of technology interchange to permit a broad use of Canadian innovation to serve as a source of foreign technology adaptable to Canadian conditions.

While the larger firms offer the greatest resources upon which an R&D capability can draw to carry through the development and commercial exploitation of new technology, IRAP support can be vital to new smaller companies to assist them in the early stages in developing new inventions when their market positions have yet to be consolidated. While the risks involved are higher than in more mature firms, they are commensurate with the added benefit of introducing not only the specific new technological advance but also new enterprises that contribute to the spectrum of Canadian industrial capability.

The technological level at which R&D is most effective is a function of the nature of the industry as well as the size of the firm. The requirement for successful innovation might involve the development of an exotic new device or the improved utilization of well-known materials. New technology of sophisticated scientific content may appear more spectacular but the economic impact of marginal improvements in the productivity of large volume commodities may prove to be greater. When properly related to appropriate business requirements, R&D has an important role to play in both industries of mature technology such as agriculture or forest products as well as in those of rapidly evolving technical and market requirements such as electronics or aerospace.

To aid in appraising the effectiveness of the IRA Program a number of companies* have described the benefits obtained from research which has received support under this program. As most of the projects are still underway, or have just been completed, it is too early to draw firm conclusions on the benefits in terms of increased sales and profitability. Other benefits, which may be equally significant, can be assessed at an earlier stage, and in the following paragraphs some examples, which are of a non-proprietary nature, are discussed.

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*Forty-four companies participated in the survey.

(1) New Research Facilities

One of the objectives of the IRA Program has been the creation of new and expanded research teams in established Canadian manufacturing industries. Examples of well established companies which have used the program to introduce R&D teams in mature industries include Canada Cement Lafarge Limited, Dominion Bridge, Consumers Glass and Stange Limited. These companies, previously without formal research activities, found that the IRAP-supported research teams proved sufficiently valuable to be retained as a permanent part of the company's operations.

(2) Increased Technological Awareness

The introduction of an R&D capability to an industrial organization represents more than the addition of a single step in the innovative process leading to a specific invention. It more often develops a competence and expertise in the field of endeavour that upgrades the scientific and technological level throughout the company's operations. Crown Zellerbach is an example of a company in a large, traditional industry which profited from the injection of scientific knowledge and methods. The research director of this company emphasized particularly the value for the company of research trained personnel who subsequently accept supervisory positions in operations and enable all branches of the company to profit from their training and experience in research.

IRAP support for the Pulp and Paper Research Institute of Canada and the Council of Forest Industries has resulted in the development of back-up knowledge and expertise which is available for the betterment of the entire industry rather than an individual company. These institutes, also, when attacking specific problems, maximize — through their many supporting members — the probability of eventual successful exploitation of the results.

(3) New Product Sales

Although it is difficult to relate sales directly to research, which operates in the early stages of technological innovation, some examples of specific new products invented in the course of IRAP-supported work can be cited.

The discovery of systemic fungicides (Vitavax) by Uniroyal has received considerable attention in view of its profound impact on agricultural productivity — this is reported in more detail under 'Case Histories' on page 6. Other specific examples are the Bell-Northern Research Electret microphones; Borden Chemicals' grouting compound, Union Carbide's differential dye nylon fibres, Canadian Technical Tape's sterilization indicator tapes, and Barringer's air pollution sensors.

(4) Improved Product Sales

The effect of R&D on sales is often through incremental improvements in quality. These benefits are frequently very difficult to isolate and

quantify, but for many companies they have been of overriding importance. Duron Canada Ltd. has been able to remain competitive in specialty building materials and to increase its sales volume. Northwest Industries has regained lost markets in fibre-glass reinforced plastics. Sherritt Gordon developed special powders with unique characteristics which contributed to a large increase of new nickel product sales. Ferranti Packard attributes a portion of a significant increase in transformer sales to IRAP-supported research.

(5) Production Cost Savings

A direct return on the investment in IRAP-supported projects is often to be found in the cost reductions made possible through improved raw material selection and manufacturing techniques. The benefits claimed by many companies as a result of a more intimate knowledge of the product or process are substantial. Some examples follow:

Company Product	*Estimated Savings*
	$
Hardboard	50,000/year
Plywood	300,000/year
Adhesive Tape	50,000/year
Wood Pulp	650,000/year
Transformers	900,000/year
Lumber & Plywood	150,000/year
Refining Operations	160,000/year
Adhesives	450,000/year
Food Spices	50,000/year

(6) Sale of Technology

Another benefit from R&D is in the income from royalties on processes or products licensed for use outside the market area of the company. One company has already derived very substantial benefits from the sale of fibre technology developed under an IRAP grant. In another case, royalty payments to the parent company have been reduced in recognition of the value of the information generated by the Canadian subsidiary.

(7) Stimulation of Economic Activity

An important indirect benefit of R&D is in the stimulation of economic activity as the result of new knowledge which is used further downstream in the innovative sequence to initiate developmental activity. The most evident examples of this are IRAP projects that have led to applications for PAIT support for subsequent developmental assistance. In this survey the following firms were found to have had IRAP-supported work which led to successful PAIT applications in the fields indicated:

Aviation Electric — fluidic control systems; Bobtex — textile machinery; Northern Electric Company — microwave components; Consolidated Bathurst — paper machine instrumentation; Cominco — lead smelting; Canadian Forest Products — hardboard products;

MacMillan Bloedel — monosulphite pulping of cedar and a Kraft pre-treatment process, Lumonics — lasers; MacNaughton-Brooks — wood flooring; Multistate — optical memory systems; Northwest Industries — fiberglass plastic tanks; Picker X-Ray — x-ray machines.

(8) Benefits to Other Industries

The benefits of R&D are not limited to the companies that exploit the results, but often are spread throughout the economy. Specific examples can be found at Dominion Bridge, where welding research is setting new standards for the industry, and Canada Cement Lafarge Ltd. which was able to make a major contribution to the development of an important new use for cement in underground mines — thus improving mine operations as well as cement sales.

(9) Expansion of Industrial Scope

Through IRAP-supported R&D a number of Canadian firms have been encouraged to enter new fields. At Picker X-Ray, a small assembly operation developed into an innovative engineering and manufacturing company responsible for the world-wide marketing of certain of the parent company's product line, while Lumonics, a new Canadian firm, has been successful in developing laser technology to the point where increasing international sales are being achieved.

(10) Increased Employment

Advances in technology create new employment opportunities by establishing new industries as well as expanding existing product lines. In many instances IRAP-supported R&D has been instrumental in increasing the range of company activities with a corresponding increase in employment. As examples, we may cite — Abrex, Picker X-Ray, Newhall, Delmar Chemicals, Uniroyal and Union Carbide.

(11) Social Benefits

Many companies consider the impact of their operations on society and take into account social as well as environmental criteria. As these considerations become more clearly defined, the scientists and engineers engaged in industrial R&D will be called upon to adapt technology to the new requirements of social objectives.

While there is as yet no generally agreed way for a broad human and social accounting, it is recognized that industrial R&D has had a positive impact on the quality of life for Canadians and that IRAP-supported work has contributed to increased employment, better working conditions and improved products for Canadian consumers. Health care is being improved through work in the pharmaceutical industries and by advances in the technology of medical x-rays and artificial limbs. Environmental problems have been attacked by new methods of pollution detection and control. Thus while the immediate objective of IRAP is the increased viability of industries which depend on new technology for survival, a secondary objective is an improvement in the quality of life generally.

The individual benefits attributable at least in part to IRAP run the full range from an easily identified and obviously novel product such as Vitavax to unidentifiable gains such as the resources released for use elsewhere through higher productivity. Thus, any attempt to apply a single yardstick to the value of the incentive scheme is an over-simplification of a complex process involving the interaction of people, money, things, and ideas.

Case Histories:

A number of companies have agreed on various occasions to the publication in Science Dimension, a bimonthly produced by NRC's Public Information Branch, of descriptions of the work they have carried out with IRAP support, and summaries of this work are provided below:

Canada Cement

In 1966 a new laboratory and pilot plant was constructed in Belleville, Ontario, and research on the stabilization of mine tailings with cement was undertaken. Techniques were developed for the consolidation with cement of mine tailings used in back-filling excavated mine chambers and for pouring load bearing mine floors from mixtures of cement and mine tailings. These procedures replaced the previous practices using timber constructions.

This work was carried out in collaboration with major mining companies that have now adopted these methods and have obtained important increases in productivity as a result. These benefits to the mining industry are associated with annual sales by Canada Cement of about $6 million for these applications, and employment for about 100 men.

Uniroyal

In 1962 an IRAP grant was made to Uniroyal for a research project on the synthesis of new chemicals for commercial application. Synthesis and evaluation of thousands of compounds led to the discovery and announcement in 1966 of the first two systemic fungicides 'Vitavax' and 'Plantvax'. These new compounds have proven to constitute a major breakthrough in the control of plant diseases. Since their discovery was made at a time when mercurial fungicides were being eliminated for ecological reasons, the impact on agricultural production has been of outstanding importance.

Vitavax is now being produced by Uniroyal in their Elmira plant to supply the growing Canadian and export markets.

Barringer Research Ltd.

With IRAP support, this small Canadian company has developed a Correlation Spectrometer which detects, analyses and charts the kinds and quantities of several pollutants in the air. The spectrometer monitors these contaminants equally well when located on the ground, a mobile vehicle, or in an aircraft. It can be used for geochemical surveys as well as in pollution control.

Significant sales of these instruments have been made on the export markets as well as in Canada. Another benefit accruing to Barringer from this work is their establishment of increased stature in the field, which has resulted in obtaining research contracts for related work.

Canadian Canners

A highly-efficient low-cost waste treatment system for fruit and vegetable canning plants has been developed as the result of a five-year research project undertaken by Canadian Canners Limited with support provided under the Industrial Research Assistance Program.

The system, known as the Grass Filtration-Pond Stabilization System, is used in heavy clay soil that does not permit subsurface drainage. It involves spraying the effluent from a canning plant in a fixed pattern over a grassy area and collecting the runoff in ponds for stabilization before releasing it into a natural waterway.

Using the system, it has been possible to produce a discharge whose strength of organic matter, or BOD, is at a level of two parts per million, well below the 15 parts per million maximum limit set by the Ontario Water Resources Commission.

It is now possible to treat the effluent from a fruit canning operation such as the one at St. David's, Ontario, (whose output equals that of a city of 150,000 people) for a capital expenditure of less than $100,000, excluding land costs.

The cost of a conventional system for treating such a waste volume would be somewhere between $500,000 and $2,000,000, depending on conditions.

Picker X-Ray Manufacturing Ltd.

A major industrial research effort in radiology has been carried out by Picker X-ray Manufacturing with IRAP support. A subsidiary of Picker Corporation of Cleveland, Ohio, the Canadian operation has the autonomy to research, design and develop certain products in the X-ray field and to manufacture and market them on export markets, including the U.S.

A chest filmer device has been developed that automatically handles precut film for exposure and processing. This system produces a processed radiograph in less than two minutes, greatly increasing the case load capacity of chest x-ray room operations without the burden of handling individual cassettes.

Bristol Laboratories of Canada

With IRAP support, scientists at Bristol Labs. have given new impetus to the acceptance of narcotic antagonists as an efficient treatment for opiate addicts by developing a new antagonist called Levo BC-2605, a potent, long-acting antagonist with very quick response. Unlike previous products, it is synthesized from relatively cheap, easily accessible starting materials.

Pharmacological and toxicological testing has already been carried out on addicted animals. Permission for clinical testing on heroine addicts has now been granted by the United States authorities.

Ayerst Research Laboratories

With a staff of 300 researchers, Ayerst has one of the largest pharmaceutical research organizations in Canada. With IRAP assistance, they have been studying the origin of atherosclerosis and have developed valuable tests and techniques now routinely used in the laboratory.

TABLE I

COMPANIES NEW TO THE IRAP PROGRAM AND NEW TO RESEARCH

Fiscal Year	Total Number of Companies Receiving Grants	Companies New to IRAP	Companies New to Research
1966/67	87	16	12
1967/68	90	18	16
1968/69	99	6	6
1969/70	111	24	23
1970/71	138	32	31
1971/72	153	21	18
1972/73	166	24	19

Since the inception of the program 242 companies have received IRAP support. Of this number, over half had no previous research facilities.

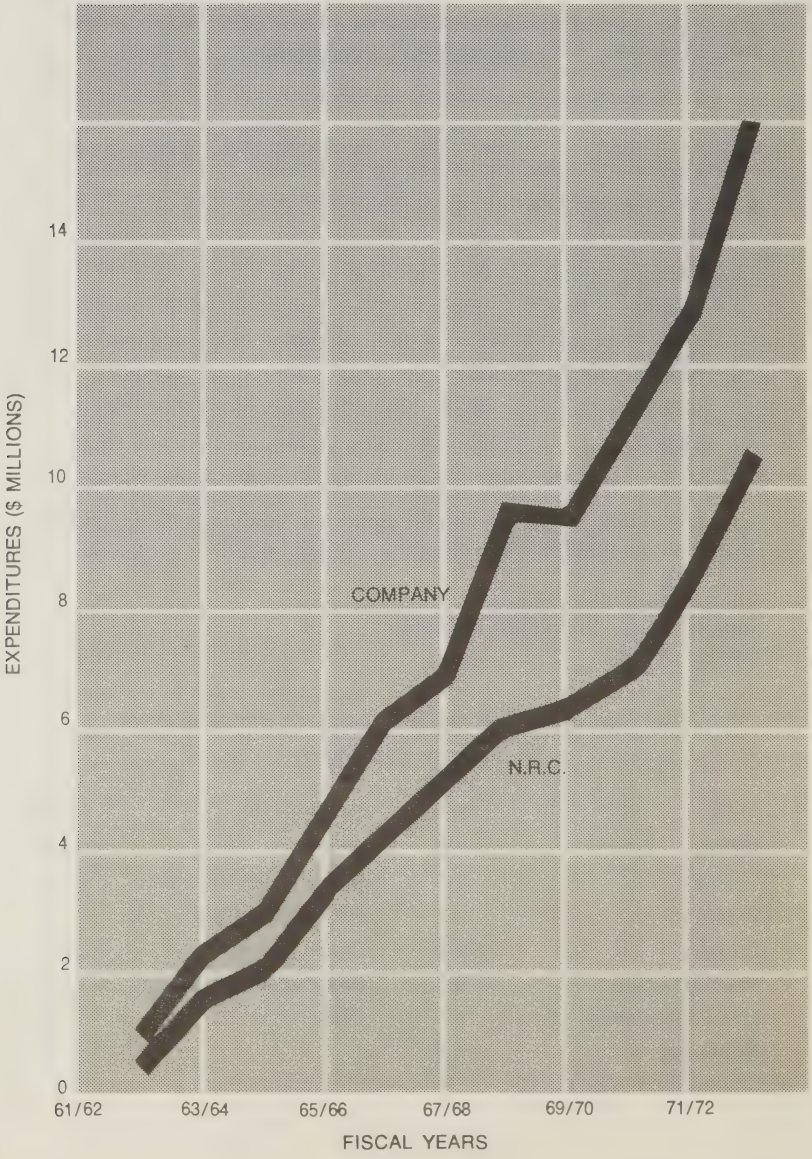
Industrial Programs Office
National Research Council of Canada
Ottawa: Ontario.

% DISTRIBUTION OF IRAP GRANTS TO INDUSTRY FISCAL YEAR 72/73

Food	7.5%	Transportation	3.2%
Rubber	3.8	Electrical	17.8
Textiles	2.5	Non-Metallic Minerals	3.6
Wood	0.6	Petroleum & Coal	1.4
Paper	12.6	Chemicals	19.3
Primary Metals	6.7	Pharmaceuticals	6.3
Metal Fabrication	0.6	Other	7.6
Machinery	6.5		

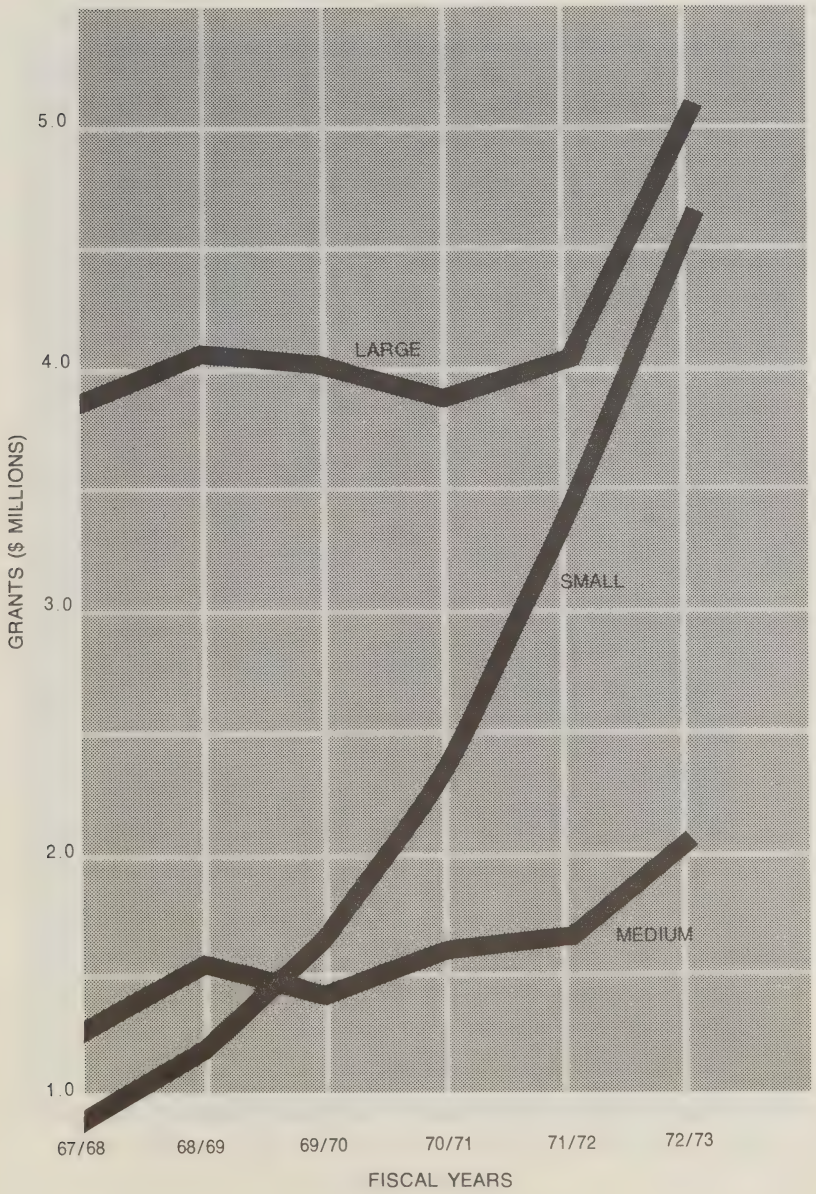
TOTAL EXPENDITURES ON IRAP PROJECTS

FIG. NO. 1



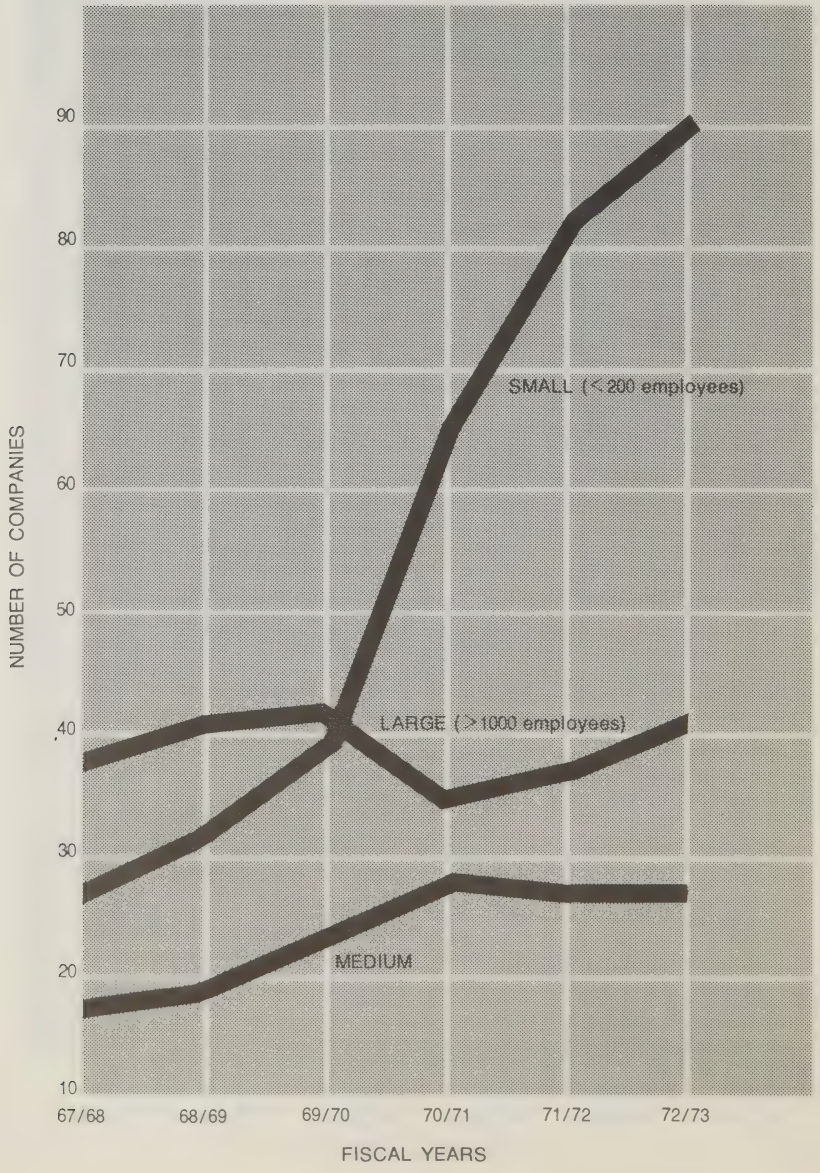
IRAP GRANTS TO COMPANIES
(BY SIZE)

FIG. NO. 2



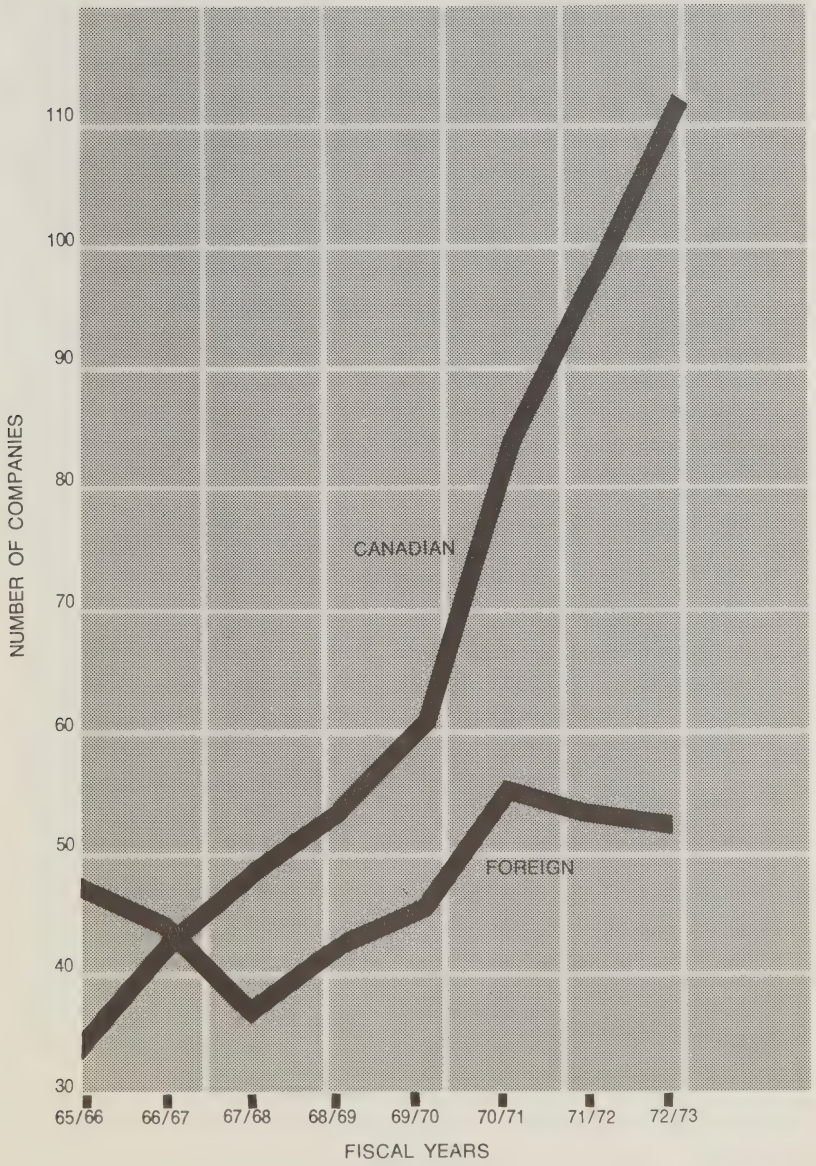
NUMBER OF COMPANIES RECEIVING IRAP GRANTS (BY SIZE)

FIG. NO. 3



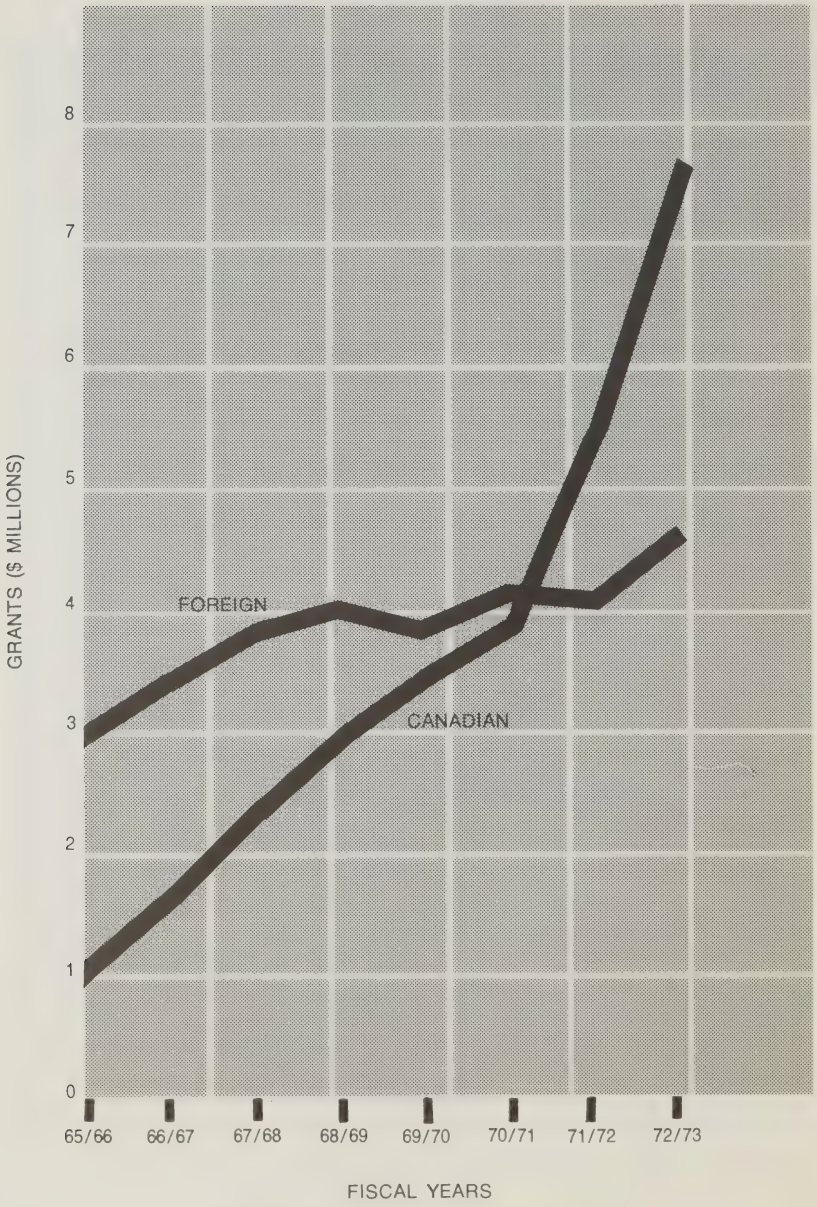
NUMBER OF COMPANIES RECEIVING IRAP GRANTS (BY OWNERSHIP)

FIG. NO. 4



IRAP GRANTS TO COMPANIES
(BY OWNERSHIP)

FIG. NO. 5



PERSONNEL EMPLOYED UNDER IRAP GRANTS
(FULL AND PART-TIME)

FIG. NO. 6